April 16

I-75 Mile Marker 70 – 72, Southbound

Black spots are potholes or cracks
a. Snowfall

Water seeps into the soil

Swell

Soil subsidence

External squeeze

c. Birth of a Pothole

1. Image source: https://www.tennessean.com/story/news/local/2022/03/11/parts-middle-tn-expected-see-up-6-inches-snow/7000268001/
Topic 1

Identify Potholes from Crowdsourced Reports

Moving eyes are more intelligent than moving scanners
Introduction & Background

Pavement distress

- **Distress type:** Patching/Potholes, Fatigue crack, Rut Depth
- **Data collection:** Laser scanner, accelerometers, image processing, citizen report
- **Limitation:** labor-intensive, costly, lagging

Crowdsourced data

- Wide coverage of road network
- Low-cost
- Real-time

Collected from networkwide app users
Introduction & Background

Challenges

- Redundant reports
- False reports

countermeasures

- Thresholds-based match
- Clustering
Study Area:
I-40, I-24, I-65, I440 and SR-155
In Nashville, TN
Pothole Reports

a. Spatial Distribution  
b. Temporal Frequency
Topic 1. Pothole Detection

Method

Spatial-temporal DBSCAN (density-based clustering)

Parameters
- Spatial threshold $\varepsilon_d$
- Temporal threshold $\varepsilon_t$
- Minimum number of points

Point type
- True reports
  - Non-core point
  - Core point
- False reports
  - Noise point
Topic 1. Pothole Detection

Results

E.g., I-40 W

- Single Spot and Pothole Zone
- Sooner
- Accurate
- Complement
- Inspection
Topic 1. Pothole Detection

Results: early detection

Earliest Work Request VS Earliest Waze Report

54 Days

Earliest Work Record VS Earliest Waze Report

52 Days
Topic 1. Pothole Detection

Results

Number of Active Potholes across the year
Can we use crowdsourced reports to evaluate the Pavement Condition?
Introduction & Background

Pavement evaluation

1. Evaluation is usually conducted once a year.
2. Collect the pavement condition data from Laser scanning.
3. Insensitive labor and cost.

Crowdsourced data

- Wide coverage of road network
- Low-cost
- Real-time
# Topic 2. Pavement Condition Evaluation

## Metrics

<table>
<thead>
<tr>
<th>Standard Metrics</th>
<th>Waze report-based</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1</strong> International Roughness Index</td>
<td><strong>1</strong> Pothole Reports per Mile</td>
</tr>
<tr>
<td>IRI</td>
<td>PRM</td>
</tr>
<tr>
<td><strong>2</strong> Rut Depth</td>
<td></td>
</tr>
<tr>
<td>Rut Depth</td>
<td></td>
</tr>
<tr>
<td><strong>3</strong> Pavement Distress Index</td>
<td></td>
</tr>
<tr>
<td>PDI</td>
<td></td>
</tr>
<tr>
<td><strong>4</strong> Present Serviceability Index</td>
<td></td>
</tr>
<tr>
<td>PSI</td>
<td></td>
</tr>
<tr>
<td><strong>5</strong> Pavement Quality Index</td>
<td></td>
</tr>
<tr>
<td>PQI</td>
<td></td>
</tr>
</tbody>
</table>
## Topic 2. Pavement Condition Evaluation

### Correlation

<table>
<thead>
<tr>
<th>Metric</th>
<th>I-40</th>
<th>I-24</th>
<th>I-65</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ρ</td>
<td>p-value</td>
<td>ρ</td>
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<tr>
<td>IRI</td>
<td>0.449</td>
<td>0.0003</td>
<td>0.186</td>
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<tr>
<td>Rut Depth</td>
<td>-0.138</td>
<td>0.2939</td>
<td>0.288</td>
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<tr>
<td>PSI</td>
<td>-0.462</td>
<td>0.0002</td>
<td>-0.205</td>
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<tr>
<td>PDI</td>
<td>0.008</td>
<td>0.952</td>
<td>-0.310</td>
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<tr>
<td>PQI</td>
<td>-0.079</td>
<td>0.5481</td>
<td>-0.321</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Metric</th>
<th>I-440</th>
<th>SR-155</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>IRI</td>
<td>0.444</td>
<td>0.0852</td>
<td>0.390</td>
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<tr>
<td>Rut Depth</td>
<td>0.157</td>
<td>0.5620</td>
<td>0.189</td>
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<tr>
<td>PSI</td>
<td>-0.441</td>
<td>0.0871</td>
<td>-0.392</td>
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<tr>
<td>PDI</td>
<td>0.049</td>
<td>0.8574</td>
<td>-0.553</td>
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<tr>
<td>PQI</td>
<td>-0.319</td>
<td>0.2278</td>
<td>-0.562</td>
</tr>
</tbody>
</table>
Topic 2. Pavement Condition Evaluation

Overall Correlation

Graphs showing the correlation between different pavement parameters and Log(PRAM).

1. IRI vs. Log(PRAM)
2. Rut Depth vs. Log(PRAM)
3. PSI vs. Log(PRAM)
4. PDI vs. Log(PRAM)
5. PQI vs. Log(PRAM)
Contribution

❖ Pothole Detection:
  ❖ Discover Pothole sooner than work request
  ❖ Provide accurate location
  ❖ Complement the work request where the pothole was not found in regular patrol
  ❖ Provide insights for manual spot patching or resurfacing
  ❖ Inspect the pavement

❖ Pavement Condition Evaluation
  ❖ Pothole Report Per Mile is strongly correlated with the standard evaluation metrics.
  ❖ The association differs from the routes.
  ❖ Overall, the Proposed index could supplement the pavement condition evaluation.
  ❖ Monitoring the pavement condition more frequently.

❖ Future Study
  ❖ Ramp pothole detection
  ❖ Local street pothole detection
Potholes on the Ramp

- Briley Pkwy and I-40
- Briley Pkwy and I-65
- Briley Pkwy and I-24

Truck Traffic?
Thank you!

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Special thanks to TDOT for continued support, and all organizers of this TSITE meeting!